Phonological alexia and agraphia: Should we remediate phonological awareness, phonological memory, or both?

Introduction

Previous research has demonstrated that the reading and spelling deficits seen in individuals with phonological alexia and agraphia are amenable to behavioral rehabilitation focused on retraining individual phoneme-grapheme correspondences (e.g., Greenwald, 2004), or training sublexical skills such as phonological awareness (e.g., Kendall et al., 2003). In most cases, however, residual, functional deficits in spelling and/or reading remain.

Beeson et al. (2010) pointed out that expectations for improvement must be tempered by persistent verbal working memory (WM) impairments, which are "likely to prevent achievement of fully normal performance on… phonological manipulation tasks, even if … sound-letter skills ultimately approximate normal" (p. 464). It is well-known that verbal STM/WM deficits are an inextricable aspect of the language problems in aphasia (e.g., Martin & Saffran, 1999; Potagas et al., 2011). Researchers have suggested that directly addressing these deficits is a necessary component to effective and efficient recovery of functional language (e.g., Majerus & Van der Linden, 2001). The missing piece for individuals receiving treatment for phonological alexia/agraphia, then, may simply comprise extending the length of time that sublexical/phonological information is activated or held in memory, such that the information may be most effectively utilized.

Studies have addressed treating verbal STM deficits in aphasia (e.g., Kalinyak-Fliszar et al., 2011; Koenig-Bruhin & Studer-Eichenberger, 2007), but such remediation has been targeted at improving "word processing," conceptualized as either repetition, verbal expression, or auditory comprehension, rather than *written* language processing. Additional studies have addressed directly treating generalized cognition (e.g., attention, working memory) to improve text-level decoding skills (e.g., Mayer & Murray, 2002; Sinotte & Coelho, 2007), but sublexical and spelling skills were not addressed. No study to our knowledge has examined utilizing verbal STM treatments, designed specifically to lengthen activation of phonological representations, to improve written language performance in individuals with phonological alexia and agraphia.

Therefore, the purpose of this study was to examine the utility of treating verbal STM to maximize utilization of trained/residual sublexical skills for reading/spelling. Two participants with aphasia and phonological alexia/agraphia received a verbal STM treatment combined with a phonological awareness protocol. We hypothesized that the addition of verbal STM training to the phonological treatment would circumvent residual deficits in mapping sublexical knowledge onto written language processing following phonological treatment, providing a more effective and/or efficient treatment outcome in terms of functional reading and writing skills.

Method

Participants. Participant 1 (P1) was a 51-year old, right handed female with 16 years of education who was 12 months post-stroke. Participant 2 was a 58-year old, right handed male with 12 years of education who was 50 months post-stroke. Both participants had received speech-language therapy focused on verbal expression following their strokes, but neither participant was enrolled in therapy during the course of the current study. Whereas both participants had experienced partial recovery of verbal expression, they each expressed interest in improving their residual reading and spelling skills.

Pre-treatment Assessment. Following IRB approval and informed consent, both participants underwent an extensive pre-treatment assessment to characterize the nature and severity of their alexia/agraphia as well as to explore their linguistic and cognitive strengths and weaknesses (Table 1). Both P1 and P2 demonstrated a significant discrepancy between lexical and non-lexical reading and spelling indicative of a phonological alexia/agraphia profile. Additionally, both participants displayed sublexical spelling errors that appeared consistent with decreased verbal working memory. P1, for example, was 100% accurate for generating the first plausible grapheme for nonwords during pre-testing, but only 20% accurate for generating the final graphemes.

Study Design and Treatment Protocols. A single-subject, multiple-phase (A-B-C-A), multiple-baseline-across subjects design was employed. Each participant completed two stages of behavioral intervention: verbal short-term memory treatment and phonological (sublexical) treatment. The stages were counterbalanced across the participants such that P1 received the verbal STM treatment first, and P2 received the phonological treatment first. Following Kalinyak-Fliszar et al. (2011), verbal short-term memory was regularly probed using a set of 2- and 3-syllable nonwords presented at 1-s, unfilled intervals for repetition. Sublexical (i.e., nonword) and lexical reading and spelling were regularly probed at a reduced rate.

Preliminary Results

P2 is currently completing Phase A of the treatment protocol; therefore, only P1's initial results are reported. P1 has completed the Level 1, phonological module of the treatment protocol outlined by Kalinyak-Fliszar et al. (2011), using the criterion of 90% accuracy x 2 consecutive trials to progress from repeating 2-3 syllable words and nonwords at 1-s unfilled to 5-s filled intervals (cf. Kalinyak-Fliszar et al.). She is currently completing Level 2 of the protocol (word pairs and triplets). Whereas P1 has made steady progress in her ability to repeat both treated and untreated stimuli (Figure 1), she has shown nominal improvement in her ability to spell words and nonwords (Figure 2). Selected standardized tests will be repeated between Phases B and C and at the completion of Phase C.

Discussion

Initial data collection supports the possible utility of specifically targeting verbal STM to improve utilization of residual or trained sublexical skills for individuals with phonological alexia and agraphia. Clinical and theoretical implications will be explored.

Selected References

Beeson, P. M., Rising, K., Kim, E. S., & Rapcsak, S. Z. (2010). A treatment sequence for phonological alexia/agraphia. JSLHR, 53, 450-468.

Kalinyak-Fliszar, M., Kohen, F., & Martin, N. (2011). Remediation of language processing in aphasia: Improving activation and maintenance of linguistic representations in (verbal) short-term memory. Aphasiology, 25(10), 1095-1131.

Koenig-Bruhin, M., & Studer-Eichenberger, F. (2007). Therapy of short-term memory disorders in fluent aphasia: A single case study. Aphasiology, 21(5), 448-458.

Martin, N., & Saffran, E. M. (1999). Effects of word processing and short-term memory deficits on verbal learning: Evidence from aphasia. International Journal of Psychology, 34(5/6), 330-346.

Potagas, C., Kasselimis, D., & Evdokimidis, I. (2011). Short-term and working memory impairments in aphasia. Neuropsychologia, 49, 2874-2878.

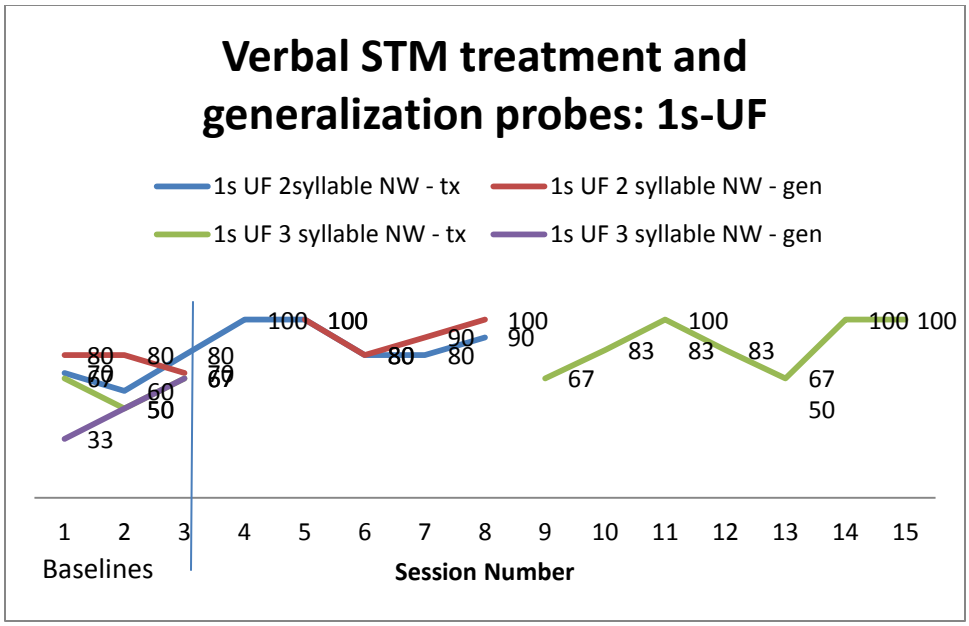
Table 1. Pre-treatment assessment for Participants 1 and 2

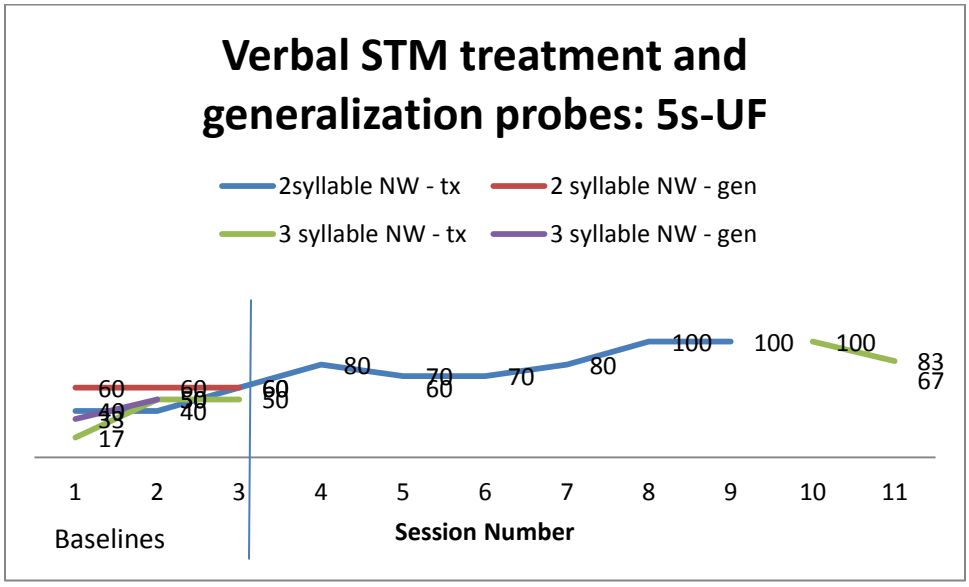
Functional skill	Behavioral Measure	Possible Score	Participant 1	Participant 2
Language - general	**Western Aphasia Battery AQ**	100	92.1 (conduction aphasia)	86.7 (Broca's aphasia)
	Boston Naming Test	60		45
Nonverbal cognition	**Test of Nonverbal Intelligence-3 Quotient**	160	110 (74th %ile)	83 (13th %ile)
Memory	**Rivermead Behavioral Memory Test General Memory Index**	160	90 (25th %ile)	*NYT
	Digit span	7	4	
Phonological Awareness	**Psycholinguistic Assessment of Language Processing in Aphasia (PALPA)**			*NYT
	15 Word Rhyme Judgments:	60	54	
	Auditory	60	52	
	Visual	20	20	
	16 Phonological Segmentation, Initial Sounds	20	14	
	17 Phonological Segmentation, Final Sounds			
Sublexical skills	36 Nonword reading	24	9	6
	45 Nonword spelling	21	2	3
Single-word spelling	39 Letter Length Spelling	24	18	20
	40 Imageability and Frequency Spelling	40	30	*NYT
	High-frequency:	20	16	
	Low-frequency:	20	14	
Single-word reading	25 Lexical Decision:			*NYT
	Words	60	59	
	Nonwords	60	56	
	31 Imageability and Frequency Reading	80	78	78
	33 Grammatical Class x Imageability	40	40	
	35 Spelling-Sound Regularity and Reading	60	60	
Functional (sentence – paragraph level) reading	**Reading Comprehension Battery for Aphasia**			*NYT
	IV Functional Reading (checkbook)	10	9	
	VII Paragraph-Picture (grammar)	10	9	
	X Morphosyntax.	10	9	
	Paragraph-factual	10	10	
	Paragraph-inferential.	10	10	
	Gray Oral Reading Test-4	140	62	
	Fluency	70	33	
	Comprehension			

*NYT – Not yet tested

Figure captions.

Figure 1. P1's verbal repetition of treated and untreated stimuli (2- and 3-syllable nonwords) at the Level 1, 1-second unfilled, 5-second unfilled, and 5-second filled delay timeframes, following the protocol of Kalinyak-Fliszar et al. (2011).


Verbal STM treatment and generalization probes: 1s-UF
1s UF 2syllable NW - tx
1s UF 2 syllable NW - gen
1s UF 3 syllable NW - tx
1s UF 3 syllable NW - gen
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Baselines
Session Number


Verbal STM treatment and generalization probes: 5s-UF
2syllable NW - tx
2 syllable NW - gen
3 syllable NW - tx
3 syllable NW - gen
1 2 3 4 5 6 7 8 9 10 11
Baselines
Session Number

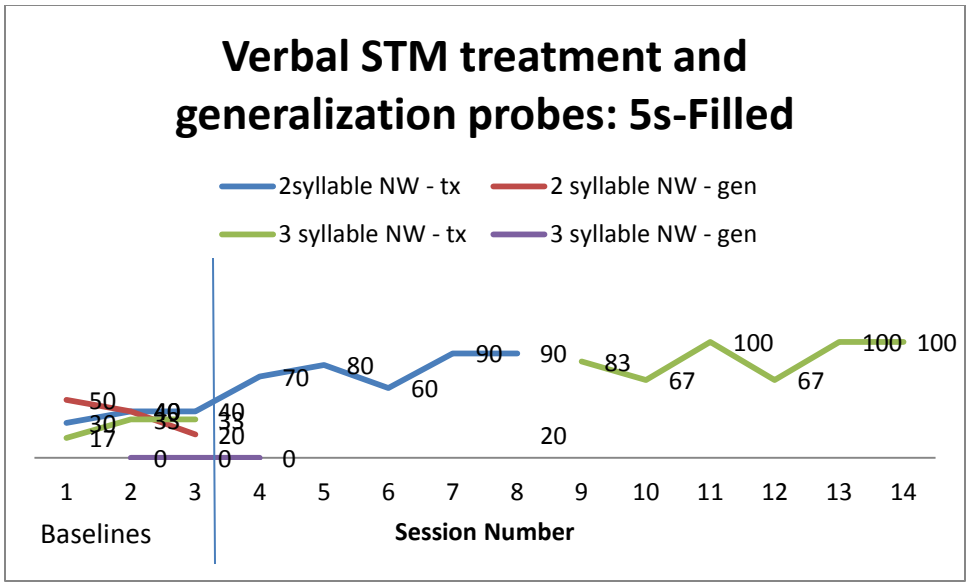

Verbal STM treatment and generalization probes: 5s-Filled
2syllable NW - tx
2 syllable NW - gen
3 syllable NW - tx
3 syllable NW - gen
50
30
17
40
33
0
40
20
0
70
80
60
90
90
20
83
67
100
67
100
100
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Baselines
Session Number

Figure 1.